puter graphics art can be applied; therefore, the detailed explanation thereof is omitted here.

[0112] When the tactile-visual UI panel possessing the multi-layer structure of the panel device provided with plural dot deformation sections in matrix arrangement is employed, and when, for example, as illustrated in FIG. **15**, the three-dimensional image virtually expressed by the two-dimensional display image of the display screen is made recognizable by a user as a visual, tactile, and three-dimensional object by the deformation control of the dot deformation section of the tactile-visual UI panel, the following processing is performed in the image processor **13** and the controller **10** of the mobile-phone terminal of the present embodiment. The processing explained below is a mere example of application of the present invention and, of course, does not limit the applicable area of the present invention.

[0113] By the rendering process in the drawing engine **14**, the image processor **13** of the mobile-phone terminal of the present embodiment generates the image data for performing the two-dimensional display of the virtual three-dimensional image as indicated in FIG. **15** on the display panel, and sends the image data to the display unit **23**. At this time, the image processor **13** sends, to the controller **10**, a three-dimensional graphics data including the coordinates of the X, Y, Z-axis which are employed in the rendering process in the drawing engine **14**.

[0114] Using the three-dimensional graphics data, the controller **10** calculates the height in the virtual three-dimensional space concerned for every polygon drawn by the computer graphics technology. The controller **10** sets up a split screen area which splits the display screen into matrices, and collects the height information in the virtual three-dimensional space of each polygon which constitutes the images to be displayed in each split screen area (the images that the three-dimensional image is divided for every split screen area), so as to correspond to each dot deformation section arranged in matrix on the tactile-visual UI panel. The controller **10** sets up the information possessing the highest value among the height information of the polygon in the split screen area concerned as the height information of the virtual three-dimensional image in the split screen area. The controller **10** generates the height information with respect to the perpendicular direction to the display panel screen surface from the height information of the virtual three-dimensional image in each split screen area, and generates the control data to respectively perform deformation control for each dot deformation section arranged in matrix in the tactile-visual UI panel, from the height information with respect to the perpendicular direction to the display panel screen surface concerned.

[0115] To give the explanation more concretely, the controller **10** generates a control data which brings to an empty (plane) state the whole dot deformation sections of each layer in the tactile-visual UI panel, at the position corresponding to the split screen area which possesses the image exhibiting the lowest height in the virtual three-dimensional space among the virtual three-dimensional image in the split screen area. The controller **10** also generates a control data which brings to an expansion state the whole dot deformation sections of each layer in the tactile-visual UI panel at the position corresponding to the split screen area which possesses the image exhibiting the highest height in the virtual three-dimensional space among the virtual three-dimensional image in the split screen area. As for the other dot deformation sections of each layer in the tactile-visual UI panel at the position corresponding to the remaining split screen area excluding the split screen area which possesses the image exhibiting the highest height in the virtual three-dimensional space and the split screen area which possesses the image exhibiting the lowest height in the virtual three-dimensional space among the virtual three-dimensional image in the split screen area, the controller **10** generates a control data which brings to an expansion or an empty (plane) state the dot deformation section of each layer in the tactile-visual UI panel at the position corresponding to the split screen area concerned, corresponding to the height of the virtual three-dimensional image in the split screen area. The controller **10** controls the pump control unit **28** and the valve control unit **29** by the control data generated above. Accordingly, as explained in FIG. **15**, the virtual three-dimensional image displayed on the display screen will be expressed as an actual three-dimensional object on the tactile-visual UI panel.

[0116] In addition, although the illustration is omitted in FIG. **17**, the mobile-phone terminal according to one embodiment of the present invention possesses components which are provided in a common mobile-phone terminal, such as: a digital camera unit for shooting a photographic image; LEDs (light emitting diodes) and the driver for a key lighting, an incoming alert lamp, etc.; a battery for supplying power to each unit and a power management IC unit to control the power; a short distance radio communication unit for performing short distance radio communication by the so-called Bluetooth method (registered trademark) and the UWB (Ultra Wide Band) method, a wireless LAN (Local Area Network), etc.; a GPS (Global Positioning System) communication unit; a slot for external memory; a receiving tuner of digital broadcasting and an AV codec unit; a timer (clock unit); and the like.

SUMMARY

[0117] As explained above, in the mobile-phone terminal according to an embodiment of the present invention, it is possible to realize a user interface which can convey information in a tactile and visual mode to a user, by performing the deformation control of a tactile-visual UI panel, and especially it is possible to realize a user interface which can change the information conveyed in a tactile mode as well as the information conveyed in a visual mode, by forming the tactile-visual UI panel in multi-layer structure, and performing deformation control for every layer.

[0118] In the mobile-phone terminal of the present embodiment, ultimate thinness of the mobile-phone terminal is realizable, because any mechanically-structured button or key is not included.

[0119] Explanation of the embodiments of the present invention described above is an example of the present invention. Therefore, the present invention is not limited to the embodiments described above, and various modifications and alterations may be possible depending on design requirements and other factors insofar as they do not deviate from the technical idea concerning the present invention.

[0120] The user interface device and the personal digital assistant according to an embodiment of the present invention can be applied not only to a mobile-phone terminal, but to PDA (Personal Digital Assistant) and a personal computer, a portable video game device, a portable digital television receiver, a car navigation system, other various terminals, and in addition, to a stationary apparatus.